

MUCKLESHOOT INDIAN TRIBE
and
U.S. FISH AND WILDLIFE SERVICE
FISHERIES ASSISTANCE OFFICE
OLYMPIA, WASHINGTON

Preliminary Report

POPULATION ESTIMATION OF THE 1976
FALL CHINOOK RUNS IN THE DUWAMISH-GREEN RIVER
AND THE LAKE WASHINGTON WATERSHED

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INTRODUCTION

The Muckelshoot Indian Tribe, with technical assistance from the Fisheries Assistance Office of the U.S. Fish and Wildlife Service and with the co-operation of the Washington Department of Fisheries, conducted population studies to estimate the size of the 1976 fall chinook runs returning to the Duwamish-Green River system and the Lake Washington watershed. In addition to estimating run size, these studies were designed to improve the fishery management capabilities of the Tribe relative to their co-operative management role with the State of Washington Departments of Fisheries and Game in U.S. v. Washington, Civil 9213. This report has been prepared in order to make the preliminary results of the studies available for use in the management of the 1977 salmon runs and to satisfy the requirements of the Bureau of Indian Affairs' contract (#141-20-0400-4684) to the Muckleshoot Indian Tribe for funding of the studies.

The chinook were tagged in the lower Duwamish River and at the Ballard Locks. Tagged fish were then recovered in the river net, marine net and sport fisheries, at hatcheries and on the spawning grounds. Run size estimates were calculated from the tagging and tag recovery information. The escapement of naturally spawning chinook salmon was estimated by subtracting the total catch, plus the hatchery return, from the estimated run size. Data on sex ratios, size composition, timing of hatchery and natural stocks, and fishery exploitation rates were also obtained.

The run size and escapement estimates presented in this report are preliminary because compilation of the final commercial and sport catch data has not been completed. Any changes in the estimates resulting from the final catch data will probably be minor. More detailed analysis of the data will be presented in a final report which will be completed by September 30, 1977.

METHODS AND MATERIALS

Tagging and Tag Recovery

The chinook were captured in the lower Duwamish River about one-half mile upstream of the mouth. A purse seine 167 fathoms in length and 8 fathoms deep was used to capture the adult chinook. Captured fish were dip-netted from the bunt end and were placed in a 3' x 3' x 2' plywood box lined with

foam rubber, kept wet to prevent injury to the fish. Fish were inspected for tags and general condition and then passed through rubber tubes to the tagging cradles. The fork length and sex were recorded while the fish were held in the tagging cradles. Metal butt-end jaw tags (National Band and Tag Company, 4-1242 and 4-1242-M) were clamped onto the right mandible of the fish. Metal jaw tags were chosen because they are not selectively taken by gill nets and because we have found that they have a higher retention rate than the spaghetti tags which were used in previous studies. In order to determine tag loss the adipose fin was removed. A 3/8" hole was punched in the upper lobe of the caudal fin of the fish with missing adipose fins from coded-wire tagging.

In the Lake Washington study, the fish were captured in a portable trap installed in the upstream exit of the fish ladder at the H. M. Chittenden Locks at Ballard. The chinook were handled and tagged in the same manner as they were on the seine boat but with one exception. At the trap, the tagged fish were placed in a live box filled with circulating fresh water pumped from the bottom of the Ship Canal. The tagged fish were released into the Ship Canal after they became active and appeared to be fully recovered.

Biologists and technicians sampled chinook in all marine and fresh water areas where they were caught commercially. Also, tags were recovered in the hatcheries and on the spawning grounds. In all areas, the fish were examined for tags, missing adipose fins, tag scars, and caudal punches. The caudal fin was cut on all dead fish on the spawning grounds to avoid duplication in counting. In addition to the areas where fish were sampled for tags, a number of tags were voluntarily returned by sport and commercial fishermen and fish processors.

Population Estimation

Straying of tagged fish to other areas was estimated in order to determine the actual number of tags that entered the Duwamish-Green River and the Lake Washington watershed. Straying was rather minor in both areas. From a total of 394 chinook tagged in the lower Duwamish River, eleven were recovered in the Lake Washington watershed, five in Elliott Bay, and one in southern Puget Sound.

Three tags from the Lake Washington study were recovered in Shilshole Bay and one was recovered in the Duwamish-Green River system. We expanded the number of tagged fish mark sampled in each area where strays were recovered by the total return to the area to estimate the total number of strays in each area.

Both mature and immature chinook were taken by commercial fishermen in the marine areas where stray tags were recovered. The commercial catch data does not distinguish between mature and immature fish; therefore, we estimated the number of mature chinook in the marine catch by using an estimate of the average weight of mature and immature chinook. These estimates were only computed for the months of September and October.

We assumed that the catch in July and August was composed entirely of mature fish and that the catch after October was all immature chinook.

Another factor which complicated the estimate for the Duwamish-Green River study was that jack salmon (chinook less than 60 cm in length) were not caught as efficiently by the purse seine as were larger fish. The recovery rate for tagged jacks in the gill net fishery was also considerably lower than the rate for the larger tagged fish. For these reasons, jacks were excluded from the population estimate, and hence, also from the estimated escapement. Jacks were included in the estimates in the Lake Washington study where the capture gear was nonselective for fish size.

The preliminary run size estimates were calculated by using the simple Petersen method. Confidence intervals were calculated by using a method described by Cochran (1963).^{1/} Estimates of total run size at entry to Shilshole and Elliott bays were obtained by adding the catch in the bays to the river population estimates. These estimates are based on the assumption that mature fall chinook caught in Elliott and Shilshole bays originated from the Duwamish-Green River system and the Lake Washington watershed, respectively. However, the estimates may be biased upwards since some fish caught in the marine areas adjacent to the mouths of the rivers may have been returning to other areas. Any error involved in estimating the size of the runs at entry to the bays will not affect the escapement estimates because they were obtained by subtracting the river catch and hatchery escapement from the river population estimates. Exploitation rates are based on the estimates of total run size to Elliott and Shilshole bays because much of the catch occurred in these areas.

RESULTS

Population Estimates

Chinook were tagged in the Duwamish-Green River on 15 purse seine days from July 28 to September 15, 1976. Chinook tagging was conducted at the trap at the Ballard Locks on a 5-day-per-week schedule from August 5 to November 9, 1976. The tagging data, mark samples, and number of tag recoveries are presented in Table 1. Fall chinook were also tagged in the Duwamish-Green River in 1975. These figures are included for comparison. The estimated run sizes, commercial and sport catches, escapement estimates, and exploitation rates are presented in Table 2.

^{1/} Cochran, W. G. 1963. Sampling Techniques, 2nd edn. John Wiley and Sons: New York.

Table 1. The number of fall chinook tagged, estimated strays, number of jacks tagged, mark samples, and number of tags recovered for the Duwamish-Green River study in 1975 and 1976 and in the Lake Washington study in 1976.

	<u>DUWAMISH-GREEN</u>		<u>LAKE WASHINGTON</u>
	<u>1975</u>	<u>1976</u>	<u>1976</u>
TAGGING			
No. Tagged	846	394	449
Strays	44	33	16
Jacks	<u>3</u>	<u>22</u>	<u>--</u>
TOTAL	799 ^{1/}	339 ^{1/}	443 ^{2/}
MARK SAMPLE			
Hatchery	3,628	2,164	6,812 ^{3/}
Fishery	475	49	--
Spawning Ground	<u>705</u>	<u>823</u>	<u>1,878</u>
TOTAL	4,808	3,036	8,690
TAG RECOVERY			
Hatchery	341	92	170
Fishery	19	3	--
Spawning Ground	<u>52</u>	<u>40</u>	<u>39</u>
TOTAL	412	135	209

^{1/} Strays and tagged jacks were subtracted from the total number of tagged fish to obtain the number of tagged chinook (excluding jacks) that entered the Duwamish-Green River.

^{2/} Only strays were subtracted from the total number of tagged fish to obtain the number of tagged chinook (including jacks) that entered the Lake Washington watershed.

^{3/} The combined total return for the Issaquah and University of Washington hatcheries.

Table 2. The estimated run sizes, commercial catches, hatchery returns, escapement estimates, and exploitation rates from fall chinook tagging studies conducted in the Duwamish-Green River in 1975 and 1976 and in the Lake Washington watershed in 1976.

	<u>DUWAMISH-GREEN</u>		<u>LAKE WASHINGTON</u>
	<u>1975</u>	<u>1976</u>	<u>1976^{1/}</u>
Population estimate	9,324	7,624	18,004
Confidence Interval (=.05)	8,755-9,973	6,726-8,771	16,438-19,898
Marine Commercial Catch	1,676	3,696	695
TOTAL RUN SIZE ^{2/}	11,780 ^{3/}	11,320	18,699
Freshwater Commercial Catch	3,199	2,325	291
Sport Catch	193	--	--
Hatchery Return	3,628	2,164	6,812 ^{4/}
Escapement ^{5/}	3,394	3,135	10,901
Exploitation Rate	40%	53%	5%

^{1/} Estimates include jacks.

^{2/} Does not include sport catch in Elliott Bay and Shilshole Bay.

^{3/} Includes 780 chinook caught in the commercial fishery in the Duwamish-Green River before we began tagging.

^{4/} The total combined return for the Issaquah and University of Washington hatcheries.

^{5/} Includes fish that spawned in Sooes and Issaquah Creeks below the hatchery racks.

Washington Department of Fisheries data for the period from 1964-1976 on hatchery returns, estimates of natural escapement, and escapement goals are presented in Tables 3 and 4. The natural escapement estimates are based on spawning ground counts in index areas. The escapement goals are based on spawning habitat availability and past measures of chinook spawning intensity in the river systems.^{2/} It is apparent that there has been a substantial decrease in both the natural and hatchery escapements since the mid-sixties. The escapement estimates from the tagging studies for naturally spawning chinook in the Duwamish-Green River in 1975 (3,394) and 1976 (3,135), which are below the escapement goal of 4,080 fall chinook, are further evidence of this decline.

Generally, the escapement estimates presented in Table 2 seem reasonable and are consistent with other information (i.e., spawning ground surveys). However, a number of factors could have created errors that would result in an error in the run size estimates, particularly in the Lake Washington study. Tag recovery ratios in the Lake Washington watershed for the Issaquah and University of Washington hatchery stocks differed by a factor of 1.7. This indicates that the assumption that all fish entering the system had an equal probability of being tagged was violated. Changes that occurred in the flow regime of the fish ladder may have significantly altered the percentage of the run using the ladder over time and thus, the number available for tagging. High water temperatures (68-70°F) occurred at the tagging site during the early part of the study and may have caused some delayed mortality. These factors will be examined more closely and will be discussed in detail in the final report.

Run Timing

Data on the week of tagging and location of tag recovery were examined to determine if there were any differences in run timing between the hatchery and natural segments of the runs (Tables 5 and 6). The hatchery stock returning to the University of Washington enters the Lake Washington watershed much later than both the Issaquah Hatchery stock and the naturally spawning stock. The Issaquah Hatchery fish and most of the natural run were through the locks by the week of September 26 - October 2, which was the peak time of entry of the University of Washington fall chinook run. Timing information on the Duwamish-Green chinook run is shown in Table 6. There is not the obvious difference in timing that there is in the Lake Washington system. It appears that the natural and hatchery segments of the run are of similar timing.

^{2/} Status of the Salmon Resource of the Puget and Coastal Regions, Washington (1975), Washington Department of Fisheries.

Table 3. Washington Department of Fisheries escapement estimates, hatchery returns, and escapement goals for fall chinook in the Lake Washington watershed from 1964 to 1976.

Year	Issaquah ^{1/} Hatchery Return	Natural ^{2/} Escapement	Total Escapement	Hatchery ^{3/} Escapement Goal	Natural ^{3/} Escapement Goal
1964	9,765	2,500	12,265		Not Established
1965	5,977	8,400	14,377		"
1966	6,690	8,500	15,190		"
1967	4,048	9,000	14,048		"
1968	5,973	3,800	9,773		"
1969	6,054	2,200	8,254		"
1970	7,035	5,100	12,135		"
1971	5,091	4,500	9,591		"
1972	4,584	1,200	5,784		"
1973	2,866	4,300	7,166		"
1974	1,809	2,100	3,909	3,000	8,200
1975	4,166	1,990	6,156	3,000	8,200
1976	2,441	1,100	3,541	4,557	3,880

^{1/} From Washington Department of Fisheries Hatcheries Statistical Report of Production and Plantings - 1975.

^{2/} Provided by Jim Ames of the Washington Department of Fisheries. These estimates may change as new data becomes available.

^{3/} From 1974, 1975, and 1976 Status of the Resource Reports, Washington Department of Fisheries.

Table 4. Washington Department of Fisheries escapement estimates, hatchery returns, and escapement goals for fall chinook in the Duwamish-Green River system from 1964-1976.

<u>Year</u>	<u>Sooes Cr.^{1/} Hatchery Return</u>	<u>Natural^{2/} Escapement</u>	<u>Total Escapement</u>	<u>Hatchery^{3/} Escapement Goal</u>	<u>Natural^{3/} Escapement Goal</u>
1964	31,720	6,200	37,920		Not Established
1965	10,515	8,000	18,515		"
1966	12,027	7,700	19,727		"
1967	5,038	7,000	12,038		"
1968	8,118	4,200	12,318		"
1969	6,650	4,200	10,850		"
1970	10,714	9,500	20,214		"
1971	8,387	6,900	15,287		"
1972	7,200	3,600	10,800		"
1973	8,275	3,400	11,675		"
1974	3,783	2,900	6,683	7,000	7,500
1975	3,759	4,060	7,819	7,000	7,500
1976	2,299	2,800	3,099	3,693	4,080

^{1/} From Washington Department of Fisheries Hatcheries Statistical Report of Production and Plantings - 1975.

^{2/} Provided by Jim Ames of the Washington Department of Fisheries. These estimates may change as new data becomes available.

^{3/} From 1974, 1975, and 1976 Status of the Salmon Resource Reports, Washington Department of Fisheries.

Table 5. Recoveries of tagged chinook by tagging week and recovery area in the 1976 Lake Washington Study.

<u>Week</u>	<u>Number Tagged</u>	<u>Number Recovered Issaquah</u>	<u>Percent Recovered</u>	<u>Number Recovered Spawning Grounds</u>	<u>Percent Recovered</u>	<u>Number Recovered U. of W.</u>	<u>Percent Recovered</u>
Aug. 1-7	11	3	27.3	1	9.0	0	0
Aug. 8-14	28	5	17.9	1	3.6	0	0
Aug. 15-21	43	9	20.9	4	9.3	1	2.3
Aug. 22-28	35	3	8.6	1	2.9	2	5.7
Aug. 29 - Sept. 4	35	3	8.6	2	5.7	4	11.4
Sept. 5-11	7	1	14.2	0	0	0	0
Sept. 12-18	119	4	3.5	5	4.2	24	20.2
Sept. 19-25	43	1	2.3	4	9.3	21	48.8
Sept. 26 - Oct. 2	45	1	2.2	1	2.2	26	57.7
Oct. 3-9	45	0	0	1	2.2	18	40.0
Oct. 10-16	29	0	0	2	6.9	15	51.7
Oct. 17-23	7	0	0	0	0	2	28.5
Oct. 31 - Nov. 6	4	0	0	0	0	2	50.0
Nov. 7-13	1	0	0	0	0	1	100.0

Table 6. Recoveries of tagged chinook by tagging week and recovery area in the 1976 Duwamish-Green River study.

<u>Week</u>	<u>Number Tagged</u>	<u>Number Hatchery Recoveries</u>	<u>Percent Recovered</u>	<u>Number Recovered on Spawning Ground</u>	<u>Percent Recovered</u>
July 25-31	4	1	25.0	0	0
Aug. 1-7	27	5	18.5	0	0
Aug. 8-14	10	5	50.0	1	10.0
Aug. 15-21	7	1	14.3	2	28.6
Aug. 22-28	137	44	32.1	7	5.1
Aug. 29 - Sept. 14	14	4	28.6	1	7.1
Sept. 5-11	72	16	22.2	2	2.8
Sept. 12-18	99	24	24.2	6	6.1
Sept. 19-25	23	6	26.1	1	4.3
Sept. 26 - Oct. 2	1	0	0	0	0

In both systems, the rates of recovery between the weeks of tagging must be interpreted cautiously. Differences in the rates of recovery between weeks may only be due to differences in the percentage of the run tagged or differences in sampling rates. Also, the fishery may operate on only one segment of the stock and thereby mask differences or similarities in timing. However, the Lake Washington and Duwamish-Green data does indicate general trends in timing that may be useful in managing the chinook runs in these systems.

SUMMARY AND CONCLUSIONS

1. The estimated run sizes into the Duwamish-Green River system for 1975 and 1976 were 9,324 and 7,605, respectively. In the Lake Washington study, the run size estimate was 18,004 chinook and the escapement estimate 10,901 chinook. The estimates in the Lake Washington system include jack salmon while jacks are excluded from the estimates of run size and escapement in the Duwamish-Green River system.
2. In the Duwamish-Green River system, the escapement estimates are below the Washington Department of Fisheries escapement goals for 1975 and 1976, even though the escapement goal was lowered for 1976. There has generally been a downward trend in the escapements since the 1960's.
3. Time of entry information from the tagging studies suggests that there is little difference in timing between hatchery and naturally spawning fall chinook in the Duwamish-Green River system. In the Lake Washington watershed, the University of Washington chinook were substantially later than the Issaquah hatchery chinook and the naturally spawning chinook.

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